THE DESIGN OF A CARE MODEL AND ASSOCIATED PERIPHERALS TO ASSIST WITH NON-COMPLIANCE OF MEDICATION

C. D. Nugent, D. D. Finlay, N. D. Black
Medical Informatics, Faculty of Informatics, University of Ulster, Northern Ireland

Abstract- **Although many ailments both mental and physical are treated using orally administered drugs, patients frequently fail to comply with their medication regimens, the most typical failure being 'under' medication [1]. This can be attributed to a number of factors, which include impaired manual dexterity, levels of cognition, poor packaging of medication, numbers of differing medications and failing vision. Various techniques have been investigated to reduce levels of non-compliance and although a number of automated systems have been developed to address this problem, not all individuals involved in the supply to intake chain for medication have been accommodated. It is therefore arguable that currently available systems are incomplete and improvements are possible if all stakeholders are catered for in the solution. It has been the aim of this study to indicate the requirements of an optimal compliance aid and to specify a suitable care model derived from the requirements of all stakeholders. It is intended that this care model should utilize the facilities offered by the Internet in terms of a dynamic adaptable communications infrastructure to include all persons involved in the supply to intake chain for orally administered medication and provide a holistic solution to the problem of non-compliance.**

Keywords - **medication compliance, care model.**

I. INTRODUCTION

The major approach of treating disease in the developed world is through the use of prescription drugs. It is estimated that on a global basis, 3 billion prescriptions are issued annually, and although the majority of medication is taken as directed, a significant number of prescriptions are wasted, as in many cases patients fail to comply to their medication regimen. This failure to comply is referred to as 'non-compliance', and is defined as the failure to take the prescribed dosage of medication at the correct time [1]. To highlight the extent of the problem it has been reported that in the USA as many as 125,000 lives are lost annually due to non-compliance with 10% of hospital admissions also being related to instances of non-compliance. On a global scale it is reported that, next to smoking, failure to comply with medication regimens is the next biggest cost in healthcare provision in the Western world [2]. It can be deduced from these statistics that the introduction of an aid to assist with accurate medication compliance will increase patient wellbeing, which, will in turn reduce healthcare costs significantly.

II. METHODOLOGY

Various compliance aids have been developed in the past. These range from simple passive solutions to complex intelligent systems. Examples of some of the passive types of devices include the likes of calendars used to indicate the drug regimen and the use of pre-packaged doses, in envelopes or foil strips, indicating the time and day for administration [3]. Another popular passive approach has been the use of a plastic box with between 28-56 compartments, suitable for a week's supply of medication [3]. With this approach the medication can be deposited in the compartments with each compartment signifying a dosage interval. There are a number of disadvantages to such solutions, the most significant being the need for a high level of manual dexterity, the requirement to pre-load the aid and little or no feedback to the medication administrators or carers. As well as the aforementioned passive solutions there are system that can be classified as 'intelligent compliance aids'. The level of functionality of such systems varies from simple recording mechanisms to elaborate notification systems. Cramer *et al*. [4] have produced a device which can be placed in the cap of a medication container, each time the cap is removed a log is incremented. Thus by reviewing the log the patient's compliance can be monitored. More elaborate systems, are also available, these not only log patient compliance, but also notify the patient audibly or visually during the medication interval in instances of non-compliance. One vendor has developed a portable system that is programmed with the patient medication regimen. At the appropriate times for medication the user is notified they must then remove the medication from the device manually to administer it. The device has a sophisticated interface that may be perceived as too complex for the elderly and people with low levels of manual dexterity. The control of how many pills have actually been taken is virtually impossible. Another vendor, has developed a device, which dispenses the prescribed amount of medication. The system is not portable and additional equipment is required for telecommunications. An elaborate system for home use was proposed in [5]. The device has the ability to record a number of vital signs from the patient in the form of physiological measurements and connect with a central server. The medication stored by the device is specific to the conditions of the physiological measurements and hence can be dispensed accordingly.

Although the aforementioned systems successfully address the non-compliance issue it can be suggested that no optimal solution is in place and several factors have not been addressed. The following outlines what can be considered as necessary features of compliance aids.

A. Technical Perspective

Any compliance aid must satisfy a number of requirements. There are several features, which are mandatory in any

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comprehensive solution, these include a non-compliance alarm, in built communications and delivery of correct medication dosage. As well as these fundamental concepts, careful consideration must be given to the following aspects.

Real-time Compliance Monitoring, Although most devices set out to monitor compliance, some only report the level at certain intervals, for example with some devices the carer may only check compliance when all the medication is taken, i.e. when the dispenser is empty, at the end of the day, or when it requires refilling. This is not sufficient when the medication is of a time critical nature (for example warferin).

Duplex Communications, Duplex communication is necessary between the compliance aid and control center for the exchange of information between both entities. For example, the required dosage (based on the prescription) will be forwarded to the compliance aid to permit the patient's drug regimen to be updated, and in instances of non-compliance information is required to be transmitted to the control center as a means of alert.

Internet, More and more systems in the medical device arena are being made Internet compatible, mainly for the purposes of home use. It would therefore be advantageous for any device to offer Internet Protocol (IP) support to aid future expansion and interoperability. The use of IP also makes geographical position irrelevant.

XML, In addition to the Internet support mentioned above, consideration should also be given to the inclusion of standards such as XML. Inclusion of such standards will enable communication with existing legacy systems and current mechanisms such as Electronic Patient Records (EPR). This will also give third party software vendors the ability to develop solutions that interact with the system.

Telemaintenance, This feature is vital to enable remote activation, provisioning or maintenance of any home based or indeed portable units, as manual interventions may not be timely enough.

B. Care Model

The aforementioned systems are mostly of a discrete nature in that they do not usually exist as a component of a larger care model. In the ever-expanding home care monitoring platform, the ability of all monitoring/support devices to be compatible is essential. Figure 1 indicates the configuration of current compliance home care assistive networks. With conventional communication techniques it is possible to relay compliance information from the home to a control center where compliance can be monitored. Additionally, in some instances, a relative or nurse is also included in the model to provide support for the patient in their home environment.

Careful consideration of the requirements of all stakeholders in the supply to intake chain of medication is of paramount importance in the design and realization of such an automated Care Model and its associated peripherals. It can be identified that this chain has a number of such

FIGURE I

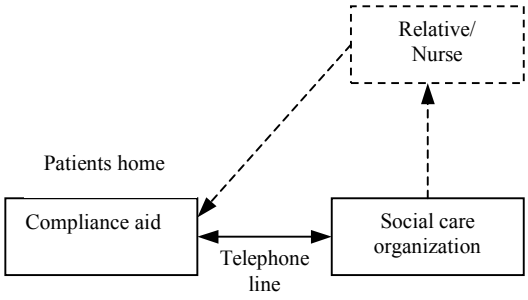

Figure 1 current compliance home care

stakeholders each with differing, yet to a certain degree, complimentary requirements and roles in the entire process. The direct stakeholders and their involvement are listed below.

GP, Following a medical examination or consultation the GP will issue the patient with a prescription. The GP is the first point of contact and therefore initiates the supply to intake chain.

Pharmacist, After the GP issues the patient with a prescription the information is passed to the pharmacist who in turn then issues the medication to the patient.

Service Platform, This is any independent organization who assist the patient. It could be an independent care provider who's role it maybe to collect medication from the pharmacist and deliver it to the patients home in addition to providing other caring duties.

Patient, The patient is the central and primary element of the chain.

In addition to those mentioned above, a number of indirect stakeholders exist. This includes but is not limited to National Healthcare Bodies, Pharmaceutical Companies, Medical Device agencies and Telecommunications companies [6]. The proposed care model and associated peripherals of this study, Medicate, is indicated in Figure 2.

It can be seen here that the Medicate system interacts with all stakeholders in the supply to intake chain of medication. The system will be based around a control center that will enable the various stakeholders to communicate using Internet protocols (i.e. TCP/IP). The General Practitioner can pass an e-prescription to the pharmacy, the service platform (independent care organization) can collect the medication from the pharmacy and deliver it to the patient's home, loading the medication into the compliance aid. All details of medication regimen can be automatically uploaded to the device by the service platform. This will reduce the patient's contact with the medication - a desirable feature, which has been identified as a cause of non-compliance. The home unit is a novel device with a portable element, hence not confining patients to their home environment. This device will communicate with the control center using Internet protocols. It will provide notification to the patient when the

FIGURE II

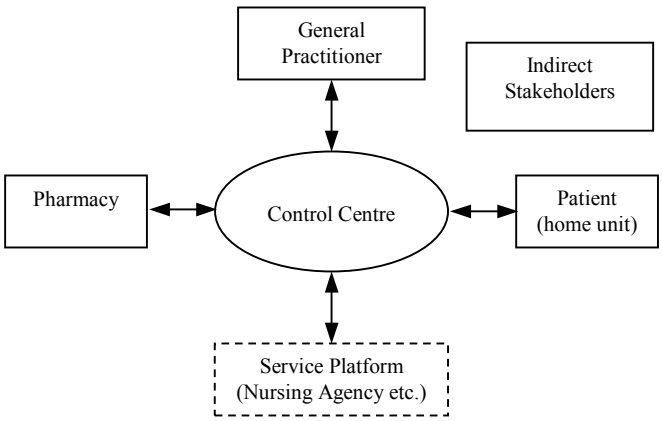

Figure 2 Proposed structure of medicate model

medication is to be delivered and it will automatically dispense the correct dosage. The system will also offer warning in instances of noncompliance and shall notify the relevant entity via the control center. With such a well-established infrastructure, tasks such as compliance monitoring and issue of repeat prescriptions can easily be automated and accommodated. It is intended that the system be developed in such a way that additional services may be added. Such services may include those that would compliment the activities of an independent nursing agency, activities such as vital signs monitoring, or lifeline services for the elderly.

The main advance over the state-of-the art is that the proposed system combines the benefits of currently available systems into one single unit and extends their present capabilities. It is intended that existing and emerging telecommunications technologies be utilized, technologies such as Short Message Service (SMS), Blue tooth and Wireless Applications Protocol (WAP).

III. DISCUSSION

In incorporating all the stake holders in the supply to intake chain the proposed Medicate project will realize the following aspects.

- Reduction in patient's contact with medications.
- One patient record accessible by all stakeholders.
- Geographical Independence.
- Real time automated control and monitoring over compliance regimen.
- Compatible and integral with other homecare platforms.

It is apparent that current compliance aids and associated monitoring platforms can provide a decrease in instances of non-compliance. With the current evaluation of the stakeholders needs in the supply to intake chain of medication, the development of a Care Model and enhanced compliance aid which addresses all of these needs is envisaged to provide a more holistic approach and anticipated further improvements in a patient's compliance to a prescribed drug regimen is expected.

IV. CONCLUSION

The problem of non-compliance is indeed one of an extremely complex nature, mainly due to all of direct and indirect factors which relate to it and additionally all the entities involved and their individual requirements. In the current study all of these issues have been identified and as best as possible addressed to provide a complete solution that can assist with the problem of patient non-compliance in the home environment and beyond. It is believed that the provision of the Medicate care model and its associated compliance aid and peripherals will further assist in reducing levels of patient non-compliance.

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